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PROPOSED REGULATION ORDER

**AIRBORNE TOXIC CONTROL MEASURE
TO REDUCE EMISSIONS OF HEXAVALENT CHROMIUM AND NICKEL
FROM THERMAL SPRAYING**

Adopt new section 93102.5, title 17, California Code of Regulations, to read as follows:

17, CCR, Section 93102.5. Airborne Toxic Control Measure to Reduce Emissions of Hexavalent Chromium and Nickel from Thermal Spraying.

(a) Applicability

(1) This regulation shall apply to all thermal spraying stationary sources that use materials containing chromium, chromium compounds, nickel, or nickel compounds.

(2) No later than 120 days after the approval of this section by the Office of Administrative Law, each air pollution control and air quality management district (district) shall:
(A) implement and enforce the requirements of this section; or
(B) propose its own ATCM to reduce emissions of hexavalent chromium, chromium compounds, nickel, or nickel compounds from thermal spraying operations.

(b) Definitions

For the purposes of this section, the following definitions shall apply:

(1) "*Add-on air pollution control device"* means equipment that is installed for the purpose of collecting and containing emissions of airborne particles from thermal spraying processes.

(2) *"Control Device with 90% Efficiency"* means an add-on air pollution control device including, but not limited to, a water curtain that collects at least 90 percent (by weight) of the airborne particles exhausted through the ventilation system.

(3) *"Control Device with 99% Efficiency"* means an add-on air pollution control device including, but not limited to, a flat dry cartridge filter that collects at least 99 percent (by weight) of the airborne particles exhausted through the ventilation system.

(4) *"Control Device with 99.999% Efficiency @ 0.5 microns"* means an add-on air pollution control device including, but not limited to, a dry cartridge filter

rated at 99.999 percent or more efficient in collecting particle sizes 0.5 microns or larger as verified per subsection d(3)(D).

(5) *"Control Device with 99.97% Efficiency @ 0.3 microns"* means an add-on air pollution control device including, but not limited to, a HEPA filter rated at 99.97 percent or more efficient in collecting particle sizes 0.3 microns or larger as verified per subsection d(3)(D).

(6) *"Detonation Gun Spraying"* means a thermal spraying process in which the coating material is heated and accelerated to the workpiece by a series of detonations or explosions from oxy-fuel gas mixtures.

(7) *"Dry Filter System"* means a dry particulate filter control system that uses filter media to remove particulate emissions from the exhaust air stream.

(8) *"Enclosure"* means a structure that surrounds a thermal spraying process and that captures and contains particulate emissions and vents them to a control device. Enclosures may have permanent or temporary openings.

(9) *"Facility"* means any thermal spraying stationary source and any equipment or materials associated with the air pollution control technique.

(10) *"Flame Spraying"* means a thermal spraying process in which an oxygen/fuel gas flame is the source of heat for melting the surfacing material. Compressed gas may or may not be used for atomizing and propelling the surfacing material to the substrate.

(11) *"High Efficiency Particulate Air (HEPA) Filter"* means a filter rated at 99.97 percent or more efficient in collecting particle sizes 0.3 microns or larger.

(12) *"Hexavalent chromium"* means the form of chromium with a valence state of +6.

(13) *"High-Velocity Oxy-Fuel (HVOF) Spraying"* means a thermal spray process in which particles are injected into a high-velocity jet formed by the combustion of oxygen and fuel.

(14) *"Intake Area"* means the area of the opening(s) through which air is first drawn from outside into the thermal spraying enclosure.

(15) *"Inward Face Velocity"* means the airflow in cubic feet per minute (cfm) divided by the open intake area in square feet, measured at the intake opening of a booth or work area.

(16) *"Leak"* means any emission containing any hexavalent chromium or nickel from any opening in the emission collection system/device prior to the intended exhaust or emission point of that emission control system/device.

(17) *"Modification"* means either:

(A) any change in thermal spraying operations which involves the new usage of materials that contain chromium, chromium compounds, nickel, or nickel compounds.
(B) any physical change in equipment specifications, equipment type, location, and/or, any change in the method of operation of or addition to an existing permit unit that requires an application for an authority to construct and/or a permit to operate. Routine maintenance and/or repair shall not be considered a physical change, so long as none of the above changes occur.
(C) the addition of any new permit unit at an existing source; or
(D) the replacement of components resulting in a fixed capital cost exceeding 50 percent of the fixed capital cost that would be required to construct a comparable new source.

(18) *"Plasma Spraying"* means a thermal spraying process in which an electric arc is used to ionize a gas and produce a plasma jet that melts and propels the coating material to the workpiece.

(19) *"Point Source"* means a facility that releases air pollutants through an intended opening such as, but not limited to, a stack, chimney, or vent.

(20) *"Stationary Source"* means any building, structure, facility or installation which emits any affected pollutant directly or as a fugitive emission. Building, structure, facility, or installation includes all pollutant emitting activities which:

(A) are under the same ownership or operation, or which are owned or operated by entities which are under common control;
(B) belong to the same industrial grouping either by virtue of falling within the same two-digit standard industrial classification code or by virtue of being part of a common industrial process, manufacturing process, or connected process involving a common raw material; and
(C) are located on one or more contiguous or adjacent properties.

(21) *"Thermal Spraying"* is any one of several processes in which metallic or nonmetallic surfacing materials are deposited in a molten or semi-molten condition on a substrate to form a coating. The surfacing material may originate in the form of powder, rod, or wire before it is heated, prior to spraying and deposition. Thermal spraying processes include: *"detonation gun spraying"*, *"flame spraying"*, *"high-velocity oxy-fuel spraying"*, *"plasma spraying"*, and *"twin-wire electric arc spraying"*.

(22) *"Twin-Wire Electric Arc Spraying"* means a thermal spraying process where two electrically conducting wires are brought close together to create an electric arc. The molten material formed in the arc is then projected by a compressed gas stream towards a work piece on which it forms a coating.

(23) *"Volume Source"* means a facility where air pollutants have initial dispersion prior to their release into the outdoor ambient air.

(24) *"Water Curtain"* means a particulate control system that utilizes flowing water (i.e., a conventional water curtain) or a pumpless system to remove particulate emissions from the exhaust air stream.

(c) Standards

Effective January 1, 2006, whenever conducting thermal spraying processes, each owner or operator of an existing, modified, or new facility shall control hexavalent chromium and nickel emissions by complying with the control efficiency requirements specified in subsections (c)(1), (c)(2) and (c)(3). Annual hexavalent chromium and nickel emissions shall be determined in accordance with the emission calculation methods in Appendix 1 or based on the results of an emissions source test. The source test must be conducted by a testing contractor certified by the Air Resources Board in the appropriate test methods, and for which test protocols and results have been reviewed and approved by the permitting agency.

(1) Existing Thermal Spraying Operations
All thermal spraying stationary sources existing as of July 1, 2005, shall control hexavalent chromium and nickel emissions discharged to the atmosphere by routing those emissions, under negative pressure, through an add-on air pollution control device(s) that meets the applicable minimum control efficiency requirements in Table1 and/or Table 2.

Table 1: Point Sources -
Control Efficiency Requirements for Existing Thermal Spraying Operations

Tier	Annual Hexavalent Chromium Emissions [1]	Annual Nickel Emissions [1]	Minimum Control Efficiency Requirements
1	$\geq$ 0.004 lbs/yr and $\leq$ 0.04 lbs/yr	$\geq$ 2.4 lbs/yr and $\leq$ 23.6 lbs/yr	90%
2	> 0.04 lbs/yr and $\leq$ 0.4 lbs/yr	> 23.6 lbs/yr and $\leq$ 236 lbs/yr	99.999% @ 0.5 microns
3	> 0.4 lbs/yr	> 236 lbs/yr	99.97% @ 0.3 microns

1. Emissions are controlled emissions, if a facility is equipped with a control device. Emissions shall be determined in accordance with the emission calculation methods in Appendix 1 or based on the results of a source emission test that has been reviewed and approved by the permitting agency.

Table 2: Volume Sources -
Control Efficiency Requirements for Existing Thermal Spraying Operations

Tier	Annual Hexavalent Chromium Emissions [1]	Annual Nickel Emissions [1]	Minimum Control Efficiency Requirements
1	≥ 0.001 lbs/yr and ≤ 0.01 lbs/yr	≥ 0.5 lbs/yr and ≤ 5.1 lbs/yr	99%
2	> 0.01 lbs/yr and ≤ 0.1 lbs/yr	> 5.1 lbs/yr and ≤ 51 lbs/yr	99.999% @ 0.5 microns
3	> 0.1 lbs/yr	> 51 lbs/yr	99.97% @ 0.3 microns

1. Emissions are controlled emissions, if a facility is equipped with a control device. Emissions shall be determined in accordance with the emission calculation methods in Appendix 1 or based on the results of a source emission test that has been reviewed and approved by the permitting agency.

(2) Most Stringent Control Efficiency Requirement
All thermal spraying stationary sources that are subject to more than one control efficiency requirement under subsection (c)(1) shall comply with the most stringent applicable requirement.

(3) New and/or Modified Thermal Spraying Operations
All thermal spraying stationary sources that are modified after July 1, 2005, or begin operation after July 1, 2005, shall comply with the Tier III, 99.97 percent at 0.3 microns control efficiency requirement specified in subsection (c)(1) upon initial startup.

(4) Enclosure Standards
Effective January 1, 2006, All emission points from thermal spraying operations subject to subsection (c)(1), (c)(2) or (c)(3) shall be vented to an emission collection system that is designed and operated according to the following criteria:

(A) Enclosures shall be exhaust ventilated in such a way that a continuous inward flow of air will be maintained at all openings in the enclosure during the thermal spraying operation.
(B) The inward face velocity of air through each opening in which air can enter the enclosure shall be a minimum of 100 feet per minute.
(C) When thermal spraying is being performed, all air inlets and access openings shall be covered to prevent the escape of dust or mist contaminants into areas outside the enclosure.
(D) Before the enclosure is opened, thermal spraying shall cease and the exhaust system shall be run for a sufficient period of time, as determined by the permitting agency, to remove contaminated air within the enclosure

so as to minimize the escape of contaminants into the workroom via the enclosure access point.

(E) The rate of exhaust from the enclosure and through the control device shall be sufficient to provide prompt clearance of contaminant-laden air within the enclosure after cessation of thermal spraying. All contaminants shall be removed within a time period as determined by the permitting agency.

(F) The design criteria and operating parameters, as necessary to determine compliance, shall be specified as conditions of the authority to construct and the permit to operate that are issued by the permitting agency.

(5) Ventilation System Standards

Effective January 1, 2006, the exhaust gas stream from the emission collection system required by subsection (c)(4) shall be ducted to a particulate matter control device meeting the applicable control efficiency requirements of subsection (c).

(A) The ventilation system and control device shall be properly maintained and kept in good operating condition at all times. Any leakage is a violation of this section.

(B) Flow meter(s) shall be installed in the ventilation system to indicate the air flow in the ducts leading to and from the control device.

(C) A magnehelic gauge shall be installed to indicate the pressure drop. This gauge must have a high and low setting for the pressure drop and must trigger an alarm system when the high or low set points are exceeded or during the cleaning cycle when the high set point is exceeded. The gauge must be designed to accurately measure pressure drops within the expected range and have an accuracy of $\pm$ 5%.

(D) The ventilation duct system shall be operated in a leak-free condition, as measured by ANSI/ASME Standard N510.

(E) Material collected by a particulate matter control system shall be discharged into closed containers or an enclosed system that is completely sealed to prevent dust emissions.

(F) Dust collectors shall be set up so that the collected dust can be emptied from them and removed without contaminating any working areas whatsoever.

(G) The dust from dry collectors should be emptied or transported in such a manner as to prevent any emissions of particulate matter into ambient air. Any method shall meet occupational exposure limitations established by the regulatory agencies having jurisdiction.

(H) The design criteria and operating parameters, as necessary to determine compliance, shall be specified as conditions in the authority to construct and the permit to operate granted by the permitting agency.

(6) Alternative Standard for Thermal Spraying Operations
In lieu of complying with the control efficiency requirements in subsections (c)(1) to (c)(4), an owner/operator may submit an emission inventory and health risk assessment to the permitting agency. The emissions inventory must be based on the potential to emit for all toxic air contaminants emitted by the facility. Emissions of hexavalent chromium and nickel from thermal spraying processes must be determined by source test or by the emission calculation procedures in Appendix 1. The health risk assessment must be prepared in accordance with the permitting agency's requirements and it must demonstrate that facility-wide emissions of toxic air contaminants result in a cancer risk of less than 10 in a million. If the permitting agency determines that the cancer risk is greater than or equal to 10 in a million, the health risk will be deemed unacceptable and the permitting agency will notify the facility of that fact. A facility must comply with the control efficiency requirements in subsection (c) within 120 days after receiving notification that the permitting agency has disapproved the health risk assessment.

(d) Performance Test Requirements and Test Methods

(1) Performance Test Requirements
Any new or modified thermal spraying stationary source subject to the emission standards in subsection (c)(3) shall conduct a performance test to demonstrate compliance with the enclosure and ventilation system standards in subsections (c)(4) and (c)(5) within 60 days after initial startup. Although 60 days are allowed for testing, all facilities must comply with emissions limits and performance standards upon initial startup.

(2) Use of Existing Performance Test
A performance test conducted prior to January 1, 2006, may be used to quantify emissions or demonstrate compliance with the standards in subsection (c), if the permitting agency approves the use of that test, and the existing test was conducted by an Air Resources Board-certified contractor, in accordance with a test protocol that was reviewed and approved by the permitting agency.

(3) Test Methods

(A) Performance testing to determine emissions of hexavalent chromium shall be conducted in accordance with the following test method:

> CARB Test Method 425, "Determination of Total Chromium and Hexavalent Chromium Emissions from Stationary Sources", last amended July 28, 1997, Section 94135, Title 17, California Code of Regulations (CCR).

(B) Performance testing to determine emissions of nickel shall be conducted in accordance with one of the following test method:

1. CARB Test Method 433, "Determination of Total Nickel Emissions from Stationary Sources", last amended September 12, 1989, Section 94145, Title 17 California Code of Regulations (CCR).

2. CARB Test Method 436, "Determination of Multiple Metals Emissions from Stationary Sources", adopted July 28, 1997, Section 94161, Title 17 California Code of Regulations (CCR).

(C) Performance testing to verify compliance with enclosure and ventilation standards shall be conducted in accordance with one of the following test methods:

1. ASME Standard N510-1989, "Testing of Nuclear Air Treatment Systems", American Society of Mechanical Engineers, 345 E. 47th St., New York, NY 10017.

2. IEST-RP-CC034.1, "HEPA and ULPA Filter Leak Tests", Institute of Environmental Sciences and Technology, 5005 Newport Drive, Suite 506, Rolling Meadows, IL 60008-3841.

3. An Independent source tester shall perform a standard tracer powder leak detection test on the ventilation system each time a cartridge filter or HEPA filter is replaced or removed for inspection. The independent source tester performing the standard tracer powder leak detection test shall introduce a minimum of one pound of tracer powder per 1000 square feet of filter media while the unit is operating. The results shall be checked by black light inspection and the results recorded.

4. Inward face velocity shall be measured with an anemometer or similar velocity monitoring device. The monitoring device shall be in good condition, of proper velocity range, properly calibrated, and operated according to the manufacturer's instructions.

(D) For New or Modified facilities and existing Tier 2 and Tier 3 facilities, control devices must use media whose efficiency has been verified by one of the following test methods:

1. ASHRAE Standard 52.2-1999, "Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size", American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., 1791 Tullie Circle NE, Atlanta, GA 30329.

2. MIL-PRF-51526A(EA), “Filter, Particulate, 340 CMH (200 CFM), 13 March 2000, U.S. Army.

3. ASME AG-1-2003, “Code on Nuclear Air and Gas Treatment”, American Society of Mechanical Engineers, 345 E. 47th St., New York, NY 10017.

4. IEST-RP-CC001.3, ”HEPA and ULPA Filters”, Institute of Environmental Sciences and Technology, 5005 Newport Drive, Suite 506, Rolling Meadows, IL 60008-3841.

(4) Pre-Test Protocol
Sources subject to the provisions of subsection (d)(1), above, must submit a pre-test protocol at least 60 days prior to conducting a performance test. The pre-test protocol shall include the performance test criteria of the end user and all assumptions, required data, and calculated targets for testing the source target pollutant concentration, the preliminary pollutant analytical data, and the planned sampling parameters. In addition, the pre-test protocol shall include information on equipment, logistics, personnel, tester certification, and any other resources necessary for an efficient and coordinated test.

(5) Test All Emission Points
Each emission point subject to the requirements of this regulation must be tested.

(e) Monitoring, Inspection, and Maintenance Requirements

(1) Monitoring Requirements
Thermal spraying stationary sources with add-on air pollution control equipment shall comply with the applicable monitoring requirements listed in Table 3.

(2) Pressure Drop Monitoring
The owner or operator shall continuously monitor the pressure drop across an add-on control device (e.g., water curtain, dry filter, HEPA filter) with a mechanical gauge. The gauge shall be located so that it can be easily visible and in clear sight of the operation or maintenance personnel. The pressure drop shall be maintained per manufacturer’s specifications to demonstrate compliance with the emission limitation for HEPA filters. If the pressure drop is outside of the acceptable limits, the owner or operator shall shut down the operation immediately and take corrective action. The operation shall not be resumed until the pressure drop is within the specified limit(s).

Table 3 – Summary of Monitoring Requirements for Sources Using Add-on Air Pollution Control Devices

	Control Equipment	Monitoring Requirements
(A)	Dry particulate filter system (e.g., dry filter cartridge, HEPA filter)	1. Continuously monitor pressure drop across the control device while conducting thermal spraying. 2. Record pressure drop once per shift.
(B)	Conventional Water Curtain	1. Continuously monitor water flow rate while conducting thermal spraying. 2. Visually inspect the water curtain for continuity to ensure that there are no gaps. 3. Record water flow rate and water curtain continuity once per week.
(C)	Pumpless Water Curtain	1. Monitor parameters that indicate booth performance, per manufacturer's recommendation, while conducting thermal spraying. 2. Visually inspect the water curtain for continuity to ensure that there are no gaps. 3. Record recommended parameters and water curtain continuity once per week.

(3) Water Curtain Monitoring

Water curtain booths should provide a continuous sheet of water down the rear wall of the booth. For all water curtain booths, the owner or operator shall visually inspect the water curtain to ensure that the sheet is continuous without any gaps or dry spots. The owner or operator of a conventional water curtain booth shall continuously monitor the water flow rate with a mechanical gauge. The owner or operator of a pumpless water curtain booth shall monitor the parameters recommended by the booth manufacturer. If the water curtain fails the continuity and/or flow requirements, the operator shall check to ensure the water flow meets or exceeds the minimum acceptable flow rate and shut down the operation immediately to take corrective action. The operation shall not be resumed until the monitored parameters comply with the specified limits.

(4) Inspection and Maintenance Requirements

Thermal spraying operations using add-on air pollution control equipment shall comply with the applicable inspection and maintenance requirements listed in Table 4.

Table 4 - Summary of Inspection and Maintenance Requirements for Sources Using Add-on Air Pollution Control Devices

	Control Equipment	Inspection & Maintenance Requirements	Frequency
(A)	Dry particulate filter system (e.g., dry filter cartridge, HEPA filter)	1. Visually inspect device to ensure there are no leaks.	1. At least once every 90 days.
		2. Visually inspect ductwork from work area to the control device to ensure there are no leaks.	2. At least once every 90 days.
		3. Conduct tracer powder test on ventilation system to ensure that there are no leaks.	3. Each time that filters are replaced or removed for inspection and at least once every 365 days.
		4. Replace filter.	4. Per manufacturer's specifications or permitting agency's requirement.
(B)	Water Curtain	1. Visually inspect device to ensure a continuous curtain of water.	1. At least once per shift.
		2. Visually inspect ductwork from booth to the exhaust stack to ensure there are no leaks.	2. At least once every 90 days.
(C)	All	1. Measure inlet face velocity.	1. At least once every 30 days

(f) Record keeping Requirements

(1) Monitoring Data Records
The owner or operator shall maintain records of monitoring data required by subsection (e) and Table 3, including the date and time the data are collected. Record keeping logs shall include the applicable acceptable limit(s) of pressure drop and water flow rate (for a conventional water curtain) or manufacturer's recommended parameter limits (for a pumpless water curtain).

(2) Inspection Records
The owner or operator shall maintain inspection records that clearly document all inspections and maintenance activities to enable the permitting agency to ascertain whether the requirements of subsection (e)(4) and Table 4 have been met. The record can take the form of a checklist and shall identify:

(A) the name of the device inspected;
(B) the date and time of inspection;
(C) a brief description of the working condition of the device during the inspection;

(D) all maintenance activities performed on the components of the air pollution control system (e.g., duct work replacement, filter replacement, fan replacement, leak repairs, etc.); and
(E) actions taken to correct deficiencies found during the inspection.

(3) Material Usage Records
For thermal spraying materials that contain chromium, chromium compounds, nickel, or nickel compounds, record the name and quantity of material used during each month of the annual reporting period, and the total usage to date.

(4) Performance Test Records
The owner or operator shall maintain test reports documenting the conditions and results of all performance tests.

(5) Equipment Malfunctions and Failures
The owner or operator shall maintain records of the occurrence, duration, cause (if known), and action taken for each equipment malfunction and/or failure.

(6) Records Maintenance and Retention
All records must be readily accessible for inspection and review at the facility for at least five years. If so requested by the permitting agency, the owner or operator must provide copies of the records to the permitting agency.

(g) Reporting Requirements

(1) Initial Notification
Thermal spraying facilities that begin using materials containing chromium, chromium compounds, nickel, or nickel compounds after January 1, 2006 shall notify the permitting agency, prior to use of these materials.

(2) Performance Test Documentation

(A) Notification of Performance Test

1. The owner or operator of a thermal spraying facility shall notify the permitting agency of his or her intention to conduct a performance test at least 60 calendar days before the performance test is scheduled. The notification shall include a test protocol, tester certification, and any other documentation required by the permitting agency.

(B) Reports of Performance Test Results
The owner or operator of a thermal spraying facility shall provide the performance test results to the permitting agency no later than 60 days following the completion of testing.

(3) Reports of Breakdowns, Equipment Malfunctions, and Failures
The owner or operator a thermal spraying facility shall report breakdowns, equipment malfunctions, and failures as required by the permitting agency.

(4) Adjustments to the Timeline for Submittal and Format of Reports
A permitting agency may adjust the timeline for submittal of periodic reports, allow consolidation of multiple reports into a single report, establish a common schedule for submittal of reports, or accept reports prepared to comply with other State or local requirements. Prior to allowing an adjustment, the permitting agency must find that the adjustment will provide the same information and will not alter or reduce the overall frequency of reporting.

Appendix 1 – Emission Calculation Method

Emissions of hexavalent chromium (Cr^{+6}) and nickel (Ni) from thermal spraying operations shall be calculated in accordance with the procedures contained in this appendix.

Step 1: Identify all thermal spraying materials that contain at least 0.1% by weight of chromium (Cr) or nickel (Ni). Include materials that contain chromium or nickel in the form of a metallic compound or alloy. Examples of compounds and alloys include, but are not limited to, stainless steel; chromium carbide (Cr_3C_2); nichrome alloys (NiCr); and chromium oxide (Cr_2O_3).

Step 2: Determine the total percentage of chromium and/or nickel contained in each thermal spraying material. These data can be obtained from the material safety data sheet (MSDS) or by contacting the manufacturer.

Step 3: Compile the annual usage for each thermal spraying material that contains chromium or nickel.

Step 4: Calculate the annual usage quantities for chromium and nickel with the following equations:

Eqn. 1: [Annual Usage, lbs Cr/yr] = [Material Usage, lbs material used/yr][weight % Cr in Material]*

Eqn. 2: [Annual Usage, lbs Ni/yr] = [Material Usage, lbs material used/yr][weight % Ni in Material]*

Step 5. Identify the appropriate emission factor(s) for each thermal spraying material, based on the applicable control efficiency level. Table 2-1 summarizes the applicable emission factors for thermal spraying materials that contain chromium, chromium compounds, or chromium alloys. Table 2-2 summarizes the applicable emission factors for thermal spraying materials that contain nickel, nickel compounds, or nickel alloys. If a material was used for more than one type of process, use the maximum emission factor.

Table 2-1: Thermal Spraying Emission Factors for Hexavalent Chromium

Process	Emission Factors (lbs Cr^{+6}/lb Cr sprayed)			
	0% Control Efficiency (Uncontrolled)	90% Control Efficiency (e.g. Water Curtain)	99% Control Efficiency (e.g. Dry Filter)	99.97% Control Efficiency (e.g., HEPA Filter)
Single-Wire Flame Spray	4.68E-03	4.68E-04	4.68E-05	1.40E-06
Twin-Wire Electric Arc Spray	6.96E-03	6.96E-04	6.96E-05	2.09E-06
Flame Spray	6.20E-03	1.17E-03	6.20E-05	1.86E-06
HVOF	6.20E-03	1.17E-03	6.20E-05	1.86E-06
Plasma Spray	1.18E-02	6.73E-03	2.61E-03	2.86E-06
Other Thermal Spraying	7.17E-03	2.05E-03	5.70E-04	2.01E-06

Table 2-2: Thermal Spraying Emission Factors for Nickel

Process	Emission Factors (lbs Ni/lb Ni sprayed)			
	0% Control Efficiency (Uncontrolled)	90% Control Efficiency (e.g. Water Curtain)	99% Control Efficiency (e.g. Dry Filter)	99.97% Control Efficiency (e.g., HEPA Filter)
Twin-Wire Electric Arc Spray	6.0E-03	6.0E-04	6.0E-05	1.8E-06
Flame Spray	1.10E-01	4.64E-02	1.10E-03	3.30E-05
HVOF	1.10E-01	4.64E-02	1.10E-03	3.30E-05
Plasma Spray	1.5E-01	3.67E-02	1.5E-03	1.72E-05
Other Thermal Spraying	9.4E-02	3.25E-02	9.4E-04	2.13E-05

Step 6. Calculate annual emissions by multiplying emission factors by usage rates, as shown below:

Eqn. 3: [Annual Emissions, lbs Cr^{+6}/yr] = [Emission Factor, lbs Cr^{+6}/lb Cr][Annual Usage, lbs Cr/yr]]*

Eqn. 4: [Annual Emissions, lbs Ni/yr] = [Emission Factor, lbs Ni/lb Ni][Annual Usage, lbs Ni/yr]]*

An example calculation is provided below:

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Material Name	% Total Chromium in Material	Annual Material Usage (lbs material/yr)	Annual Usage of Total Chromium (lbs Cr/yr)	Emission Factor (lb Cr^{+6}/lb Cr)	Emissions (lbs Cr^{+6}/yr)
Example – Powder XYZ	20%	150 lbs/yr	(20%)*(150) = 30 lbs Cr/yr	2.61E-03	(30)*(2.61E-03) = 7.83E-02 lbs Cr^{+6}/yr